

PRELIMINARY DATA SUMMARY

July 1989

U.S. Army Engineer Waterways Experiment Station  
Coastal Engineering Research Center  
Field Research Facility  
Duck, North Carolina

## PRELIMINARY DATA SUMMARY

CERC Field Research Facility  
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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## PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

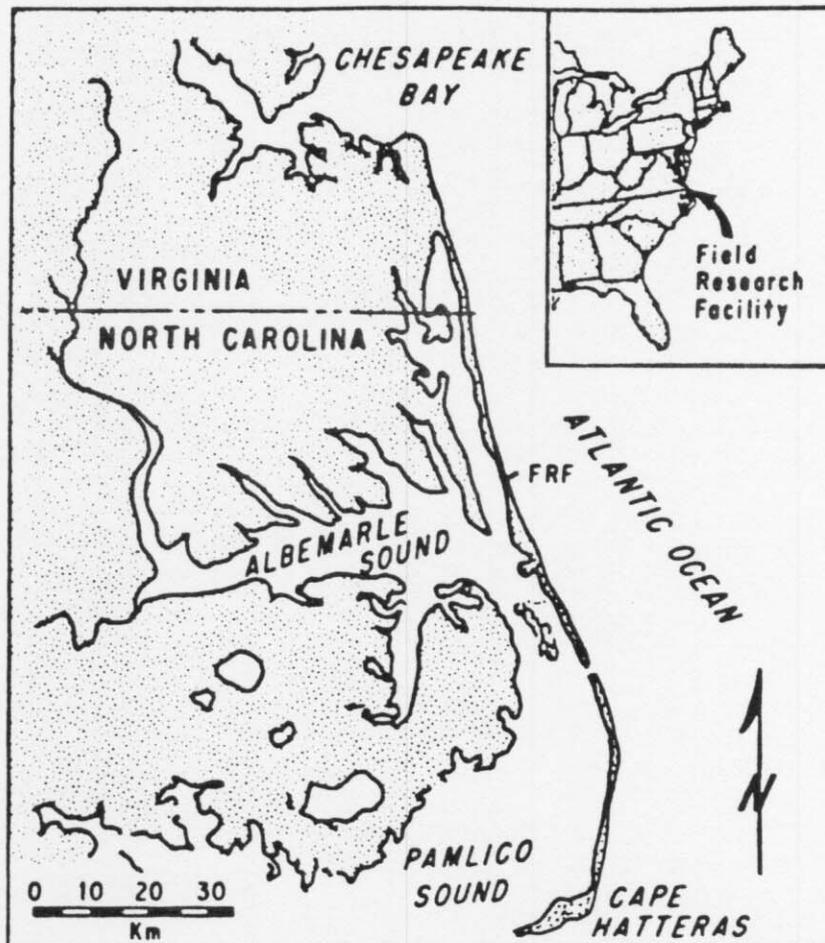


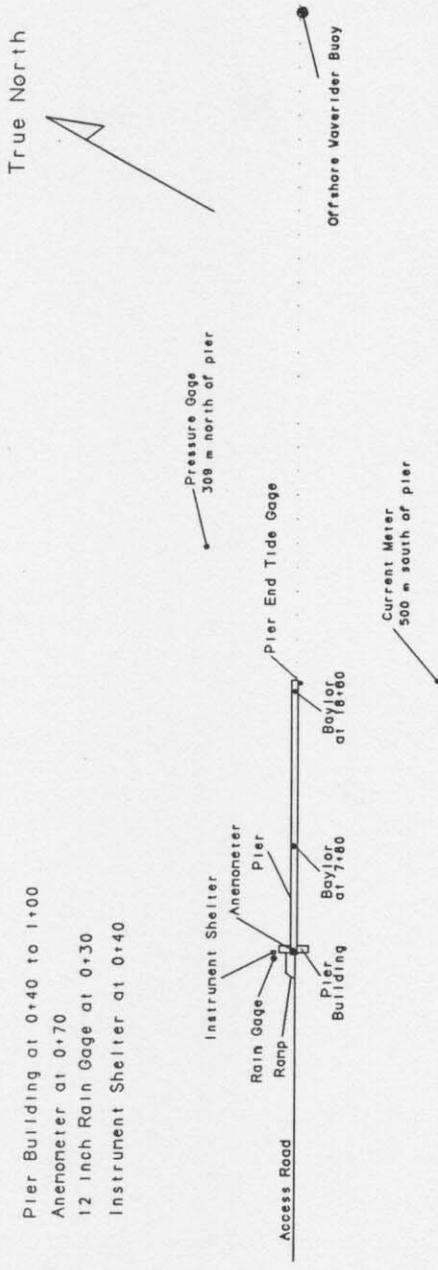
Figure 1. FRF location map

Table 1: Instrument Status/Data Availability

JUL 1989

Gage ID	Description/Remarks	Depth at Sensor		Day of the month																														
				1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3			
616	Barometric Pressure		Gage Status	*****																														
			Data Collected	***** / *****																														
			Analog Record	*****																														
604	Precipitation		Gage Status	*****																														
			Data Collected	***** / *****																														
624	Air Temperature		Gage Status	*****																														
			Data Collected	***** / *****																														
932	Anemometer at Seaward End of Pier Elevation 19 m (NGVD)		Gage Status	*****																														
			Data Collected	***** / *****																														
645	Baylor staff at station 7+80 on FRF pier	see Figure 7	Gage Status	*****																														
			Data Collected	***** / ***** / *****																														
625	Baylor staff at station 18+60 on FRF pier	see Figure 7	Gage Status	*****																														
			Data Collected	***** / *****																														
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status	*****																														
			Data Collected	***** / ***** / *****																														
630	Waverider buoy 6.0 km offshore	Approx. 23 m NGVD	Gage Status	***** / - - - *****																														
			Data Collected	***** / - - - *****																														
679	Current meter 500 m south of FRF pier (0.6 km offshore)	see Figure 7	Gage Status	- - - - - Gage Inoperative - - - - -																														
			Data Collected	- - - - -																														
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	*****																														
			Data Collected	*****																														
Supplemental Observations (daily oceanographic and meteorological observations)			Daily observation	*****																														

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -



- Pier Building at 0+40 to 1+00
- Anemometer at 0+70
- 12 Inch Rain Gage at 0+30
- Instrument Shelter at 0+40

CURRITUCK SOUND

ATLANTIC OCEAN

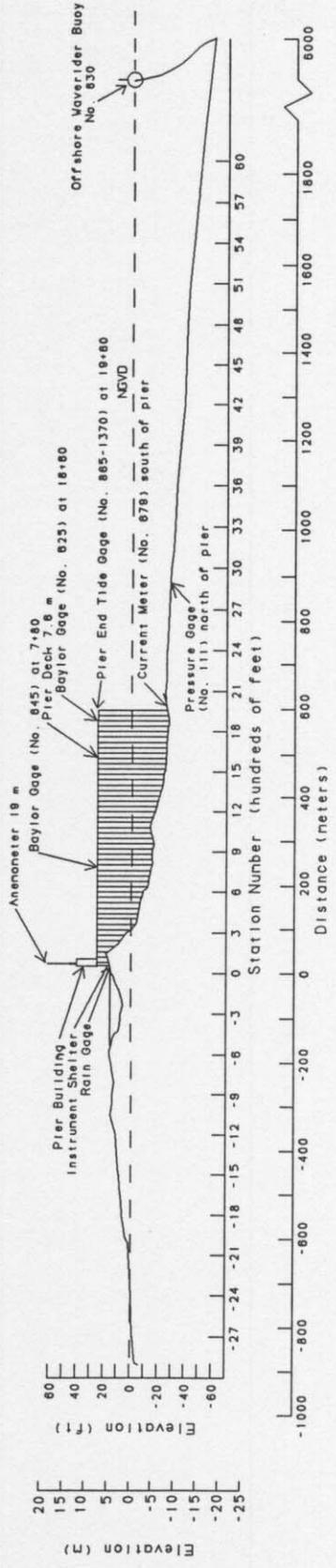


Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

## PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured on top of the laboratory building at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $\text{m/s} \times 1.943 = \text{kn}$

Table 2: Meteorological Data

Jul 1989						
Day	Hour	*Wind Speed m/sec	*Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	6	39	22.3	1017.9	0
	700	5	33	23.0	1017.9	0
	1300	5	42	24.3	1017.9	0
	1900	4	58	22.5	1017.2	0
2	100	1	80	20.7	1017.2	0
	700	4	6	22.9	1018.2	0
	1300	4	69	26.0	1017.9	0
	1900	5	126	23.9	1016.2	0
3	100	2	157	22.6	1016.5	0
	700	3	138	25.3	1017.2	0
	1300	7	120	27.8	1016.9	0
	1900	6	129	24.7	1016.2	0
4	100	3	118	23.6	1016.5	0
	700	5	92	25.4	1015.9	0
	1300	5	98	28.2	1016.2	0
	1900	8	103	25.1	1014.5	0
5	100	6	145	24.5	1014.8	0
	700	5	214	24.0	1016.2	12
	1300	7	183	25.4	1016.5	37
	1900	9	189	24.6	1017.2	4
6	100	6	197	25.0	1017.9	0
	700	7	214	26.4	1019.2	0
	1300	6	194	27.2	1018.6	0
	1900	6	203	25.8	1016.9	0
7	100	7	232	24.9	1016.9	0
	700		Power Failure			0
	1300	8	248	29.4	1014.2	0
	1900	7	230	27.1	1012.8	0
8	100	6	246	25.1	1011.8	0
	700	5	265	25.5	1012.5	0
	1300	8	308	27.0	1012.1	0
	1900	3	8	25.6	1013.1	28
9	100	3	67	24.1	1014.5	0
	700	2	113	26.3	1015.9	0
	1300	4	131	30.1	1017.2	0
	1900	6	195	27.0	1015.9	0
10	100	5	209	25.4	1016.2	0
	700	8	217	26.1	1016.5	0
	1300	7	211	31.8	1014.5	0
	1900	5	198	29.7	1012.8	0
11	100	7	237	27.8	1012.1	0
	700	5	261	28.0	1012.8	0
	1300	3	228	32.9	1012.5	0
	1900	4	191	31.1	1011.1	0
12	100	4	249	29.9	1011.8	0
	700	6	152	26.4	1012.1	0
	1300	4	43	28.4	1011.4	0
	1900	3	76	25.5	1011.1	0
13	100	1	4	25.1	1009.4	0
	700	5	243	26.4	1008.4	0
	1300	10	220	24.9	1006.7	0
	1900	5	242	24.5	1004.7	2
14	100	5	289	24.2	1004.0	0
	700	7	331	23.0	1006.4	0
	1300	6	34	26.0	1009.1	0
	1900	3	114	24.7	1011.8	0
15	100	1	196	22.8	1013.5	0
	700	2	123	26.4	1016.2	0
	1300	3	140	29.0	1017.5	0
	1900	6	141	25.8	1017.2	0
16	100	8	161	25.8	1016.5	0
	700	9	164	24.8	1015.2	2
	1300	5	186	25.5	1012.8	4
	1900	10	205	25.7	1008.7	9

(Continued)

Table 2: Meteorological Data

Jul 1989

Day	Hour	Wind	Wind	Temperature	Atm	Precipitation
		Speed	Direction	deg C	Pressure	mm
		m/sec	deg TN		mb	
17	100	7	290	22.2	1010.4	16
	700	4	315	21.5	1012.8	0
	1300	4	51	23.0	1013.5	0
	1900	9	61	22.6	1013.1	0
18	100	7	68	21.8	1012.5	102
	700	6	27	23.0	1014.2	0
	1300	6	30	25.1	1014.5	0
	1900	6	47	23.4	1015.2	0
19	100	1	97	22.8	1014.8	0
	700	4	70	24.5	1014.8	0
	1300	5	103	27.4	1013.5	0
	1900	8	130	25.2	1010.8	0
20	100	6	194	24.9	1009.4	0
	700	6	214	25.4	1009.1	3
	1300	5	224	30.0	1009.1	0
	1900	9	204	27.8	1010.4	0
21	100	3	213	26.2	1012.1	0
	700	5	238	25.8	1016.5	0
	1300	5	185	29.1	1018.2	0
	1900	8	192	25.8	1018.6	0
22	100	6	222	25.6	1020.3	0
	700	3	278	27.1	1022.3	0
	1300	5	210	29.0	1023.0	0
	1900	7	220	26.2	1022.3	0
23	100	5	249	25.7	1023.0	0
	700	3	266	26.3	1023.6	0
	1300	6	245	29.5	1022.3	0
	1900	4	255	29.0	1020.6	0
24	100	4	283	27.6	1020.6	0
	700	4	345	26.0	1021.3	2
	1300	5	70	28.3	1021.6	0
	1900	8	84	25.9	1020.6	0
25	100	2	82	25.3	1022.3	0
	700	5	41	26.2	1023.0	0
	1300	4	55	28.0	1022.3	0
	1900	3	82	25.1	1020.9	0
26	100	1	145	23.7	1020.6	0
	700	2	310	25.6	1020.9	0
	1300	3	116	29.7	1019.6	0
	1900	6	156	26.2	1017.2	0
27	100	4	223	26.1	1016.2	0
	700	6	236	25.7	1016.2	0
	1300	4	190	28.4	1014.5	0
	1900	7	211	27.3	1011.8	0
28	100	5	221	26.0	1010.1	0
	700	4	291	25.5	1009.1	0
	1300	2	36	29.3	1008.4	0
	1900	2	89	26.2	1008.1	0
29	100	3	205	25.8	1010.1	0
	700	9	41	24.4	1012.8	0
	1300	8	21	25.9	1014.5	0
	1900	6	39	23.8	1015.2	0
30	100	5	68	23.2	1016.2	0
	700	4	81	24.5	1017.5	0
	1300	4	113	27.6	1017.5	0
	1900	6	116	24.5	1015.5	0
31	100	6	329	24.9	1015.5	0
	700	7	203	26.1	1014.5	0
	1300	5	255	31.1	1013.8	0
	1900	4	206	24.3	1013.5	27
		Resultant		Mean	Mean	Total
		2	182	25.9	1015.1	248

\* Anemometer at end of pier used (gage No. 932)

(Sheet 2 of 2)

### PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height  $H_{mo}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all  $H_{mo}$  and  $T_p$  values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Jul 1989

Day	Hour	645		625		111		630	
		Baylor at 7+80 Hmo,m	T,sec	Baylor at 18+60 Hmo,m	T,sec	Pressure Gage Hmo,m	T,sec	Offshr Hmo,m	Wvrdr T,sec
1	0100	0.62	5.22	0.90	5.22	0.74	4.83	0.83	4.83
	0700	0.45	4.74	0.65	4.41	0.65	4.66	0.68	5.95
	1300	0.50	5.02	0.71	5.82	0.61	5.69	0.68	5.82
	1900	0.39	4.66	0.56	5.82	0.54	6.24	0.59	6.09
2	0100	0.40	5.12	0.67	5.45	0.61	5.33	0.68	5.69
	0700	0.26	6.40	0.56	6.56	0.58	6.74	0.69	6.92
	1300	0.36	5.45	0.58	7.11	0.55	7.11	0.55	7.31
	1900	0.31	4.83	0.55	7.31	0.51	7.31	0.63	7.31
3	0100	0.27	6.92	0.48	7.76	0.45	7.11	0.51	7.53
	0700	0.23	6.92	0.44	7.11	0.46	6.92	0.48	7.11
	1300	0.30	6.56	0.45	6.74	0.45	6.74	0.54	7.11
	1900	0.25	6.56	0.41	7.53	0.44	6.24	0.53	6.24
4	0100	0.24	7.76	0.40	7.31	0.41	8.00	0.48	7.76
	0700	0.24	7.76	0.40	7.11	0.46	7.31	0.53	6.74
	1300	0.33	4.74	0.55	7.53	0.53	6.74	0.62	7.76
	1900	0.66	6.74	0.81	6.74	0.88	5.82	1.06	6.74
5	0100	0.52	7.11	0.93	7.53	0.86	7.11	1.01	6.56
	0700	0.62	6.24	0.79	6.74	0.88	6.92	1.05	6.92
	1300	0.57	5.95	0.88	7.31	0.84	7.31	1.04	6.24
	1900	0.50	6.40	0.67	8.26	0.78	6.56	0.96	6.09
6	0100	0.45	6.56	0.68	6.24	0.65	6.92	0.79	6.92
	0700	0.36	4.57	0.58	9.14	0.57	9.85	0.69	10.24
	1300	0.39	5.82	0.61	9.85	0.62	10.24	0.61	9.48
	1900	0.31	12.19	0.52	9.85	0.56	9.85	0.55	9.14
7	0100	*		0.52	12.19	0.53	11.64	0.69	5.02
	0700			Power Failure					
	1300	0.45	6.56	0.43	10.24	0.48	11.13	*	
	1900	0.29	10.24	0.41	10.67	0.44	10.24	*	
8	0100	0.24	10.24	0.34	10.67	0.34	10.24	*	
	0700	0.19	9.14	0.30	9.14	0.29	9.14	*	
	1300	0.21	10.24	0.30	10.24	0.30	9.85	*	
	1900	0.16	10.67	0.27	9.48	0.28	9.14	*	
9	0100	0.26	7.11	0.34	8.26	0.32	6.40	*	
	0700	0.27	5.33	0.39	4.06	0.39	4.20	*	
	1300	0.24	4.57	0.33	8.26	0.35	8.83	*	
	1900	0.24	3.33	0.39	3.28	0.33	3.33	*	
10	0100	0.20	5.22	0.31	10.24	0.31	9.14	*	
	0700	0.18	8.83	0.38	8.53	0.31	9.14	*	
	1300	0.20	9.14	0.31	8.83	0.34	9.14	*	
	1900	0.22	8.26	0.38	8.53	0.40	9.85	*	
11	0100	0.22	9.48	0.33	9.48	0.37	8.53	0.51	8.26
	0700	0.20	9.14	0.35	9.85	0.35	9.48	0.43	8.26
	1300	0.21	9.48	0.33	9.48	0.37	9.85	0.39	9.48
	1900	0.17	8.83	0.35	8.83	0.37	8.53	0.37	7.76
12	0100	0.20	9.48	0.32	9.85	0.40	9.48	0.38	9.48
	0700	0.41	3.37	0.57	8.53	0.53	9.14	0.53	8.53
	1300	0.29	9.14	0.45	9.85	0.44	9.85	0.55	9.85
	1900	0.23	9.85	0.36	9.48	0.38	10.24	0.43	9.48
13	0100	0.39	4.66	0.50	4.66	0.55	4.83	0.60	8.83
	0700	0.30	4.49	0.40	8.83	0.42	9.85	0.47	4.74
	1300	0.26	9.48	0.36	9.14	0.39	9.85	0.58	9.14
	1900	0.27	5.33	0.34	9.14	0.39	9.48	0.44	9.48
14	0100	0.29	9.48	0.35	8.53	0.39	8.53	0.44	5.95
	0700	0.60	6.56	0.59	6.40	0.62	6.40	0.83	6.24
	1300	0.76	5.69	0.88	13.47	0.98	5.69	1.12	5.33
	1900	0.60	5.69	0.72	12.80	0.90	12.80	0.85	12.80
15	0100	0.50	12.19	0.76	12.19	0.92	12.19	0.78	12.19
	0700	0.43	12.19	0.67	11.64	0.76	11.13	0.73	11.13
	1300	0.44	11.13	0.76	11.13	0.81	11.13	0.84	11.13
	1900	0.49	11.13	0.77	11.13	0.89	10.67	0.78	10.67
16	0100	0.56	10.67	0.85	10.67	1.00	10.24	0.97	10.24
	0700	0.52	10.67	0.77	10.67	0.92	11.13	1.00	10.24
	1300	0.63	4.83	0.91	10.24	0.99	10.24	1.04	10.24
	1900	0.53	9.48	0.86	9.85	0.82	9.85	0.92	9.48

\* Electronic problems

(Continued)

Table 3: Wave Data

Jul 1989

Day	Hour	645		625		111		630	
		Baylor Hmo,m	at 7+80 T,sec	Baylor Hmo,m	at 18+60 T,sec	Pressure Hmo,m	Gage T,sec	Offshr Hmo,m	wvrdr T,sec
17	0100	*		0.69	9.48	0.72	9.48	0.81	9.48
	0700	*		0.56	9.14	0.66	9.48	0.69	9.48
	1300	0.38	9.48	0.60	8.83	*		0.69	9.14
18	1900	0.81	6.56	0.78	9.48	*		0.92	8.83
	0100	0.89	6.56	1.14	4.92	*		1.23	6.92
	0700	1.04	5.33	1.12	6.56	1.12	5.45	1.29	6.09
19	1300	0.76	4.66	0.90	4.57	0.94	4.34	1.00	6.40
	1900	0.74	5.95	0.84	5.33	0.95	5.12	1.05	5.57
	0100	0.80	5.95	0.92	5.57	0.96	5.82	1.01	6.24
20	0700	0.66	5.95	0.83	7.76	0.90	6.24	0.91	5.69
	1300	0.59	5.82	0.75	6.92	0.71	7.11	0.72	6.92
	1900	0.58	5.69	0.71	6.40	0.70	6.40	0.87	7.31
21	0100	0.40	5.33	0.58	6.92	0.60	8.83	0.70	6.74
	0700	0.38	5.82	0.53	5.82	0.58	9.14	0.74	6.56
	1300	0.39	5.82	0.57	6.74	0.60	8.00	0.86	6.56
22	1900	0.42	5.33	0.56	8.26	0.64	8.26	0.93	5.82
	0100	0.30	6.40	0.50	8.53	0.53	8.53	0.70	8.26
	0700	0.36	5.95	0.50	7.11	0.56	8.26	0.76	7.76
23	1300	0.31	7.31	0.46	8.26	0.53	8.53	0.68	6.56
	1900	0.36	5.82	0.47	8.00	0.51	8.26	0.73	6.74
	0100	0.29	6.09	0.44	7.76	0.50	8.53	0.68	8.53
24	0700	0.31	7.31	0.48	8.53	0.56	7.53	0.68	7.53
	1300	0.37	5.95	0.52	17.07	0.52	8.26	0.64	6.09
	1900	0.34	17.07	0.47	17.07	0.56	17.07	0.71	17.07
25	0100	0.30	17.07	0.47	17.07	0.57	17.07	0.64	17.07
	0700	0.30	16.00	0.50	16.00	0.54	16.00	0.61	16.00
	1300	0.27	16.00	0.44	16.00	0.51	16.00	0.62	16.00
26	1900	0.26	16.00	0.47	15.06	0.57	16.00	0.57	16.00
	0100	0.43	16.00	0.50	16.00	0.58	16.00	0.65	8.00
	0700	0.32	15.06	0.52	14.22	0.54	14.22	0.55	15.06
27	1300	0.41	14.22	0.58	15.06	0.58	15.06	0.61	15.06
	1900	0.55	15.06	0.74	14.22	0.69	14.22	0.76	14.22
	0100	0.43	15.06	0.64	15.06	0.63	14.22	0.65	14.22
28	0700	0.34	14.22	0.64	14.22	0.58	14.22	0.62	14.22
	1300	0.40	14.22	0.63	14.22	0.58	14.22	0.69	13.47
	1900	0.38	14.22	0.68	14.22	0.63	14.22	0.71	14.22
29	0100	0.40	14.22	0.67	7.11	0.67	6.92	0.76	6.92
	0700	0.42	13.47	0.80	7.53	0.74	8.26	0.79	6.74
	1300	0.42	8.26	0.77	8.83	0.88	8.00	0.89	8.53
30	1900	0.39	8.53	0.80	8.53	0.80	8.53	0.81	8.53
	0100	0.33	8.26	0.68	8.26	0.70	8.26	0.81	8.00
	0700	0.25	8.00	0.62	8.00	0.62	8.26	0.65	8.26
31	1300	0.31	8.00	0.54	7.53	0.57	7.76	0.59	7.31
	1900	0.22	8.53	0.43	8.26	0.50	8.53	0.56	8.26
	0100	0.22	12.80	0.40	8.53	0.46	9.14	0.44	7.53
32	0700	0.19	8.53	0.40	13.47	0.39	8.83	0.43	8.83
	1300	0.21	8.53	0.38	13.47	0.40	12.80	0.47	7.76
	1900	0.21	12.80	0.34	8.83	0.43	12.80	0.44	8.83
33	0100	0.19	12.80	0.33	12.80	0.39	12.80	0.35	8.83
	0700	0.75	3.66	0.84	3.66	0.98	3.66	0.93	3.94
	1300	0.90	6.40	0.99	6.40	1.10	6.09	1.35	6.56
34	1900	0.72	6.56	0.80	6.56	0.83	6.24	1.08	6.56
	0100	0.76	6.56	0.77	6.56	0.82	6.40	0.87	6.40
	0700	0.53	6.09	0.60	5.95	0.60	5.69	0.67	6.09
35	1300	0.38	5.82	0.52	5.95	0.51	5.82	0.55	5.82
	1900	0.42	5.22	0.55	7.53	0.48	8.00	0.59	7.76
	0100	0.41	3.56	0.59	7.11	0.58	6.92	0.71	6.74
36	0700	0.29	8.00	0.43	8.26	0.46	8.00	0.54	8.26
	1300	0.20	7.76	0.37	8.26	0.42	8.00	0.49	8.00
	1900	0.28	7.53	0.41	7.76	0.41	8.53	0.51	8.26
Mean		0.40	8.26	0.57	9.03	0.59	8.94	0.71	8.50
Std dev		0.18	3.39	0.19	3.04	0.20	2.96	0.21	2.86

\* Electronic problems

(Sheet 2 of 2)

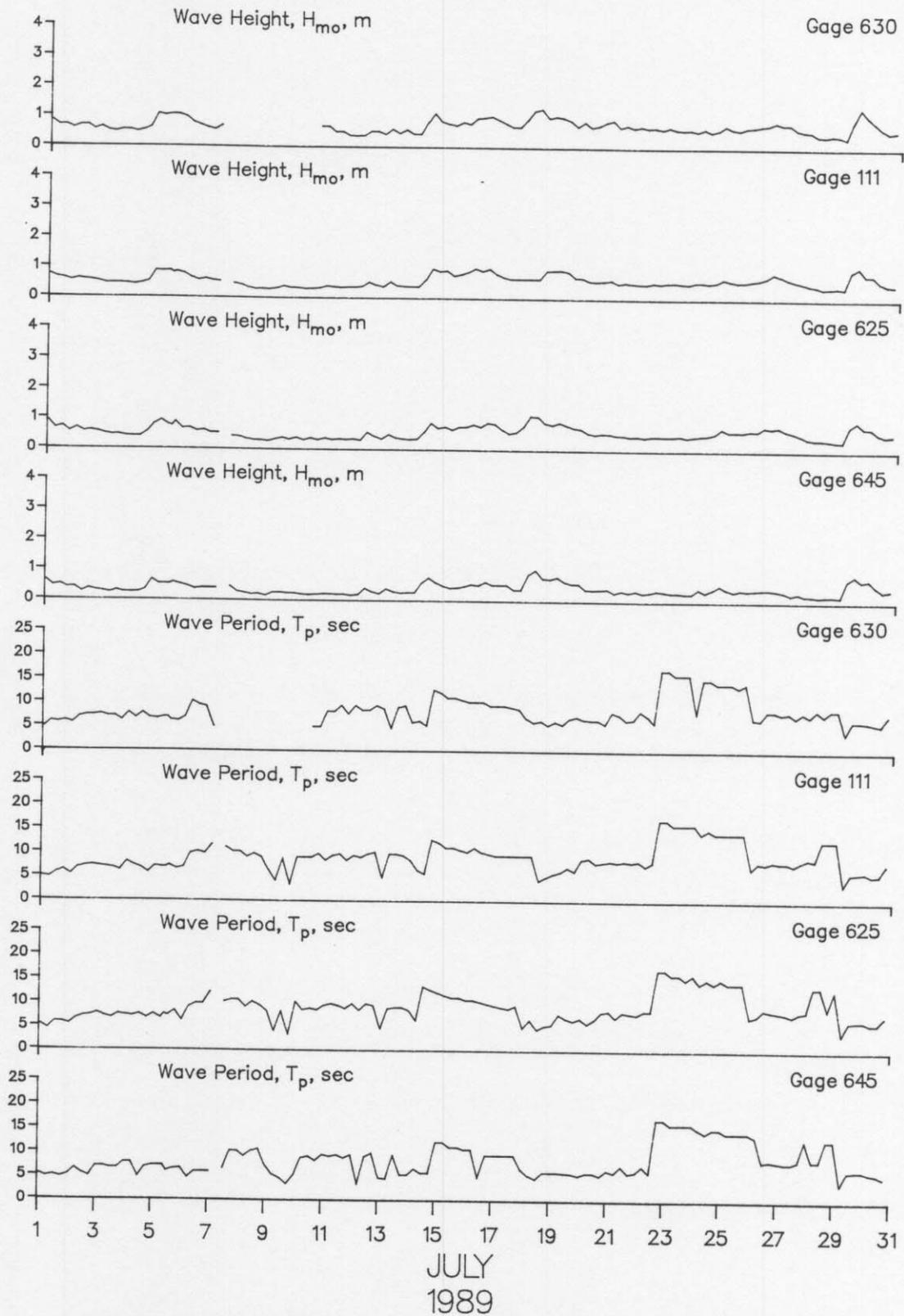


Figure 3. Time history of wave heights and periods

#### PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data  
Jul 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 619m Offshore Depth -4.8m (NGVD) ID #679			
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir	
1	0100	Along Cross Result											
1	0700	Along Cross Result	29 9 30	S on 177	165	24 10 26	S on 182	North	2	N			
1	1300	Along Cross Result											
1	1900	Along Cross Result											
2	0100	Along Cross Result											
2	0700	Along Cross Result	29 6 30	S on 171	152	9 3 10	N off 359	South	24	N			
2	1300	Along Cross Result											
2	1900	Along Cross Result											
3	0100	Along Cross Result											
3	0700	Along Cross Result	34 0 34	N  340	152	17 0 17	N  340	South	22	N			Gage Inoperative
3	1300	Along Cross Result											
3	1900	Along Cross Result											
4	0100	Along Cross Result											
4	0700	Along Cross Result	24 9 26	N on 321	165	22 7 23	N on 323	South	53	N			
4	1300	Along Cross Result											
4	1900	Along Cross Result											
5	0100	Along Cross Result											
5	0700	Along Cross Result	29 10 31	N off 359	177	44 4 44	N on 334	South	85	N			
5	1300	Along Cross Result											
5	1900	Along Cross Result											

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore    off = offshore

Table 4: Current Data (Continued)  
Jul 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Dye 12m offshore (surface)		619m Offshore Depth -4.8m (NGVD) ID #679	Speed   Dir		
			Speed	Dir		Speed	Dir		Speed	Dir	
6	0100	-Along Cross Result									
6	0700	-Along Cross Result	13 18 22	N off 33	165	16 10 19	N off 11	South	15 N		
6	1300	-Along Cross Result									
6	1900	-Along Cross Result									
7	0100	-Along Cross Result									
7	0700	-Along Cross Result	0 12 12	off 70	177	7 7 10	N off 22	South	24 N		
7	1300	-Along Cross Result									
7	1900	-Along Cross Result									
8	0100	-Along Cross Result									
8	0700	-Along Cross Result	30 3 31	S on 166	152	27 8 28	S off 143	North	0	Gage Inoperative	
8	1300	-Along Cross Result									
8	1900	-Along Cross Result									
9	0100	-Along Cross Result									
9	0700	-Along Cross Result	25 6 26	S on 174	165	0 6 6	off 70	South	1 S		
9	1300	-Along Cross Result									
9	1900	-Along Cross Result									
10	0100	-Along Cross Result									
10	0700	-Along Cross Result	25 11 28	N off 4	177	23 7 24	N off 357	South	26 N		
10	1300	-Along Cross Result									
10	1900	-Along Cross Result									

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Continued)  
Jul 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter		
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Dye 12m offshore (surface)			619m Offshore Depth -4.8m (NGVD) ID #679		
			Speed	Dir	Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
11	0100	Along Cross Result										
11	0700	Along Cross Result	0 12 12	off 70	177	0 10 10	off 70	South	31	N		
11	1300	Along Cross Result										
11	1900	Along Cross Result										
12	0100	Along Cross Result										
12	0700	Along Cross Result	47 0 47	S 160	165	0 23 23	on 250	South	27	N		
12	1300	Along Cross Result										
12	1900	Along Cross Result										
13	0100	Along Cross Result										
13	0700	Along Cross Result	0 14 14	off 70	177	0 4 4	off 70	South	18	N		
13	1300	Along Cross Result										
13	1900	Along Cross Result										
14	0100	Along Cross Result										
14	0700	Along Cross Result	102 20 104	S on 171	177	41 18 45	S on 184	North	91	S		
14	1300	Along Cross Result										
14	1900	Along Cross Result										
15	0100	Along Cross Result										
15	0700	Along Cross Result	47 14 49	S on 177	177	32 2 32	N on 337	South	105	N		
15	1300	Along Cross Result										
15	1900	Along Cross Result										

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Continued)  
Jul 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter		
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Dye 12m offshore (surface)		619m Offshore Depth -4.8m (NGVD) ID #679				
			Speed	Dir		Speed	Dir	Location	Speed	Dir	Speed	Dir
16	0100	-Along Cross Result										
16	0700	-Along Cross Result	44 11 45	N on 326	189	68 7 68	N off 346	South	18	N		
16	1300	-Along Cross Result										
16	1900	-Along Cross Result										
17	0100	-Along Cross Result										
17	0700	-Along Cross Result	87 0 87	S  160	165	20 4 21	N on 329	South	26	N		
17	1300	-Along Cross Result										
17	1900	-Along Cross Result										
18	0100	-Along Cross Result										
18	0700	-Along Cross Result	38 0 38	S  160	177	32 3 32	S off 154	North	18	S		
18	1300	-Along Cross Result										
18	1900	-Along Cross Result										
19	0100	-Along Cross Result										
19	0700	-Along Cross Result	51 18 54	S on 179	177	0 5 5	on 250	North	37	S		
19	1300	-Along Cross Result										
19	1900	-Along Cross Result										
20	0100	-Along Cross Result										
20	0700	-Along Cross Result	8 11 14	N off 36	165	11 6 12	N off 11	South	52	N		
20	1300	-Along Cross Result										
20	1900	-Along Cross Result										

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Continued)  
Jul 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 619m Offshore Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
21	0100	Along Cross Result										
21	0700	Along Cross Result	5 2 5	S on 182	165	16 2 17	N on 331	South	76	N		
21	1300	Along Cross Result										
21	1900	Along Cross Result										
22	0100	Along Cross Result										
22	0700	Along Cross Result	17 16 23	N off 22	165	5 3 6	N off 11	South	27	N		
22	1300	Along Cross Result										
22	1900	Along Cross Result										
23	0100	Along Cross Result										
23	0700	Along Cross Result	10 0 10	S  160	177	8 6 10	N off 17	South	58	N		Gage Inoperative
23	1300	Along Cross Result										
23	1900	Along Cross Result										
24	0100	Along Cross Result										
24	0700	Along Cross Result	13 4 13	N on 321	177	4 3 5	N off 11	South	47	N		
24	1300	Along Cross Result										
24	1900	Along Cross Result										
25	0100	Along Cross Result										
25	0700	Along Cross Result	34 15 37	S on 184	177	10 3 11	S on 179	North	49	S		
25	1300	Along Cross Result										
25	1900	Along Cross Result										

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Jul 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 619m Offshore Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed	Dir
26	0100	-Along Cross Result										
26	0700	-Along Cross Result	18 3 19	N off 349	189	19 1 19	N off 343	South	50	N		
26	1300	-Along Cross Result										
26	1900	-Along Cross Result										
27	0100	-Along Cross Result										
27	0700	-Along Cross Result	18 14 23	N off 17	177	17 12 21	N off 15	South	70	N		
27	1300	-Along Cross Result										
27	1900	-Along Cross Result										
28	0100	-Along Cross Result										
28	0700	-Along Cross Result	0 3 3		177	0 4 4	off 70	South	9			
28	1300	-Along Cross Result										
28	1900	-Along Cross Result										
29	0100	-Along Cross Result										
29	0700	-Along Cross Result	51 23 56	S on 184	207	68 0 68	S on 160	North	110	S		
29	1300	-Along Cross Result										
29	1900	-Along Cross Result										
30	0100	-Along Cross Result										
30	0700	-Along Cross Result	20 5 21	S on 174	165	8 0 8	N on 337	North	16	S		
30	1300	-Along Cross Result										
30	1900	-Along Cross Result										

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Concluded)  
Jul 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Dye 12m offshore (surface)		619m Offshore Depth -4.8m (NGVD) ID #679			
			Speed	Dir	Speed	Dir	Location	Speed	Dir	Speed	Dir
31	0100	Along Cross Result									
31	0700	Along Cross Result	25 28 38	N off 28	177	10 9 13	N off 22	South	26	N	
31	1300	Along Cross Result									
31	1900	Along Cross Result									

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

## PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Jul 1989

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0920	30		55	21	24.3	1.0170	2.7
2	0718	100		50	11	24.3	1.0172	3.4
3	0740	120	135		6	25.6	1.0162	2.7
4	0930	120			6	25.0	1.0178	1.8
5	0755	120			23	21.1	1.0224	3.0
6	0804	140			15	17.8	1.0240	1.8
7	0800	135			18	16.1	1.0243	3.0
8	0927	135			5	23.9	1.0212	5.8
9	0718	110	10		17	25.6	1.0176	3.0
10	0732	120			18	22.2	1.0216	2.7
11	0705	120			14	17.2	1.0240	2.1
12	0826	100	25		14	26.1	1.0170	2.4
13	0755	15	145		6	25.6	1.0171	2.1
14	0757	5	45		19	22.8	1.0210	1.5
15	0842	90			18	26.4	1.0176	2.4
16	0836	130		95	24	26.6	1.0176	2.1
17	0734	105			11	15.6	1.0250	2.7
18	0742	25		30	35	22.8	1.0212	1.5
19	0800	10			26	25.0	1.0160	2.1
20	0800	135			12	23.8	1.0205	2.1
21	0807	145			16	23.4	1.0212	2.7
23	0935	130			12	24.5	1.0214	2.4
22	0910	125			21	24.5	1.0212	2.7
24	0745	20	85		15	24.5	1.0212	2.7
25	0745	30	110		12	27.2	1.0154	2.1
26	0800	115			21	27.8	1.0152	2.4
27	0812	125			16	23.4	1.0220	2.7
28	0740	120			9	19.5	1.0230	2.7
29	1010	15			37	25.6	1.0204	1.5
30	0812	40		45	27	25.6	1.0174	2.7
31	0755	125			18	26.7	1.0197	2.4

## PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

# FRF Tide Heights

Jul 1989

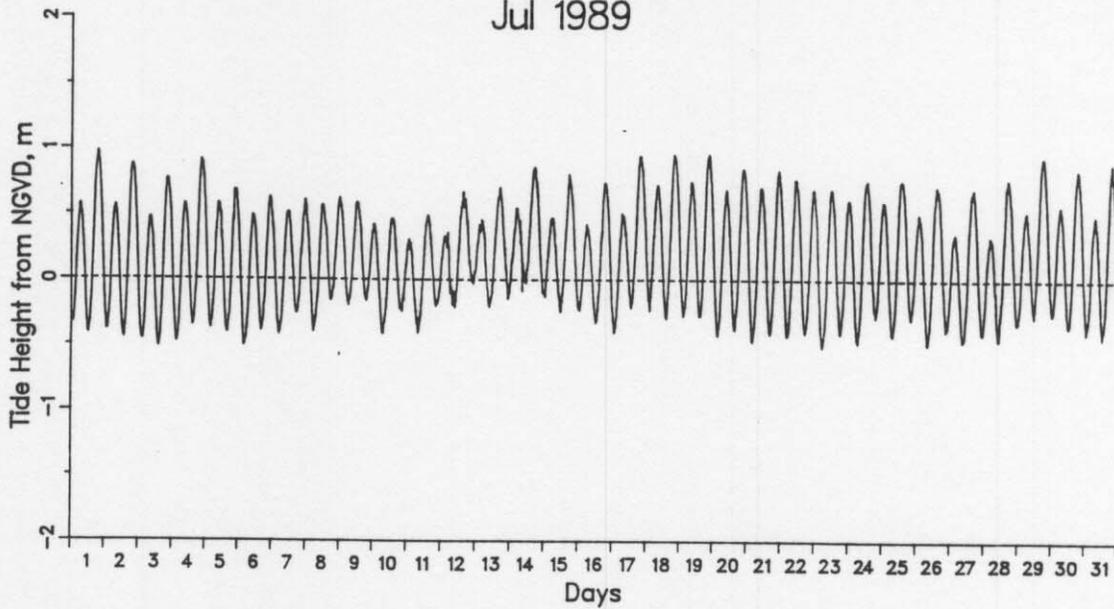


Figure 4. Water Level Time History

### Monthly Water Levels, m NGVD

Extreme Low = -0.52 on day 3 at 1306 EST  
Extreme High = 0.97 on day 1 at 1748 EST  
Monthly Mean = 0.16  
Mean Low = -0.36  
Mean High = 0.65  
Mean Range = 1.01

Table 6: Water Levels, m NGVD

		Jul 1989			
Mid-Cycle Day	Time	Low	High	Mean	Range
1	612	-0.41	0.57	0.06	0.98
1	1837	-0.39	0.97	0.33	1.36
2	703	-0.45	0.56	0.06	1.01
2	1928	-0.46	0.87	0.25	1.33
3	753	-0.52	0.47	-0.03	0.98
3	2018	-0.48	0.77	0.18	1.24
4	843	-0.46	0.58	0.08	1.03
4	2109	-0.37	0.91	0.31	1.29
5	934	-0.41	0.58	0.08	0.98
5	2159	-0.51	0.68	0.11	1.19
6	1024	-0.45	0.49	0.02	0.94
6	2249	-0.42	0.63	0.11	1.05
7	1115	-0.36	0.52	0.09	0.87
7	2340	-0.40	0.61	0.12	1.01
8	1205	-0.30	0.57	0.16	0.87
9	30	-0.20	0.62	0.21	0.82
9	1255	-0.16	0.59	0.21	0.75
10	121	-0.41	0.42	0.04	0.84
10	1346	-0.30	0.47	0.10	0.77
11	211	-0.41	0.30	-0.03	0.71
11	1436	-0.27	0.49	0.12	0.76
12	301	-0.22	0.36	0.06	0.58
12	1527	-0.17	0.67	0.29	0.84
13	352	-0.21	0.46	0.14	0.67
13	1617	-0.15	0.70	0.28	0.84
14	442	-0.09	0.55	0.23	0.64
14	1707	-0.11	0.86	0.40	0.97
15	532	-0.25	0.47	0.13	0.72
15	1758	-0.23	0.80	0.28	1.04
16	623	-0.33	0.42	0.05	0.75
16	1848	-0.40	0.74	0.20	1.14
17	713	-0.35	0.51	0.12	0.86
17	1938	-0.24	0.94	0.41	1.18
18	804	-0.30	0.72	0.23	1.02
18	2029	-0.28	0.96	0.37	1.23
19	854	-0.28	0.75	0.21	1.02
19	2119	-0.42	0.96	0.31	1.38
20	944	-0.38	0.69	0.14	1.07
20	2210	-0.47	0.85	0.23	1.32
21	1035	-0.41	0.70	0.15	1.12
21	2300	-0.43	0.83	0.19	1.26
22	1125	-0.41	0.77	0.17	1.17
22	2350	-0.52	0.69	0.09	1.20
23	1216	-0.41	0.69	0.13	1.10
24	41	-0.48	0.61	0.08	1.09
24	1306	-0.32	0.76	0.22	1.08
25	131	-0.42	0.60	0.10	1.02
25	1356	-0.30	0.76	0.25	1.06
26	222	-0.49	0.51	0.03	1.00
26	1447	-0.39	0.71	0.20	1.10
27	312	-0.47	0.35	-0.06	0.82
27	1537	-0.41	0.69	0.17	1.10
28	402	-0.46	0.33	-0.05	0.79
28	1628	-0.33	0.77	0.23	1.10
29	453	-0.32	0.52	0.10	0.84
29	1718	-0.26	0.93	0.38	1.19
30	543	-0.35	0.57	0.10	0.92
30	1808	-0.40	0.84	0.26	1.24
31	634	-0.44	0.50	0.02	0.94
31	1859	-0.37	0.89	0.34	1.26

PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in June and the two surveys in July on profile line 188, located 517 m south of the pier. The most significant change was the 10 m shoreward migration of the berm (120 m) with some deposition and subsequent flattening of the beach extending from the berm crest to the toe of the dune (70 - 120 m). Only minor changes are visible on the remainder of the profile.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1988. The major change (100 m) to the envelope is a result of the changes to the berm.

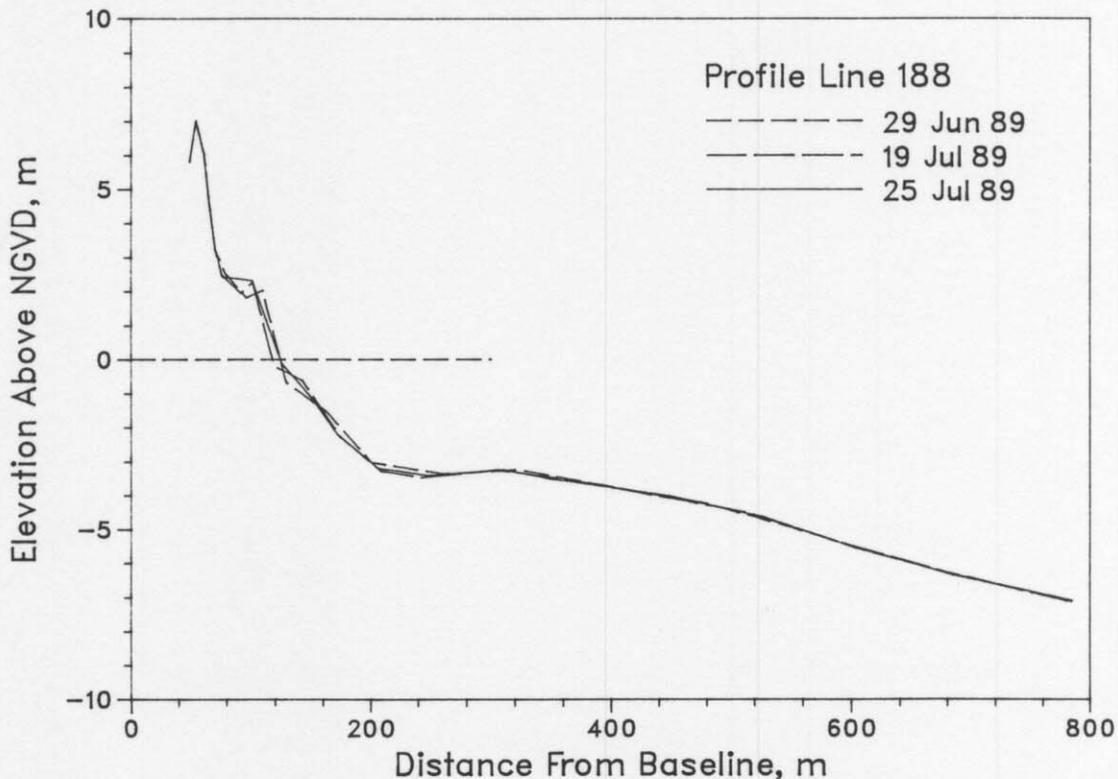


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1988. The prominent change (100 m) visible on the foreshore is a result of the berm development late in the month.

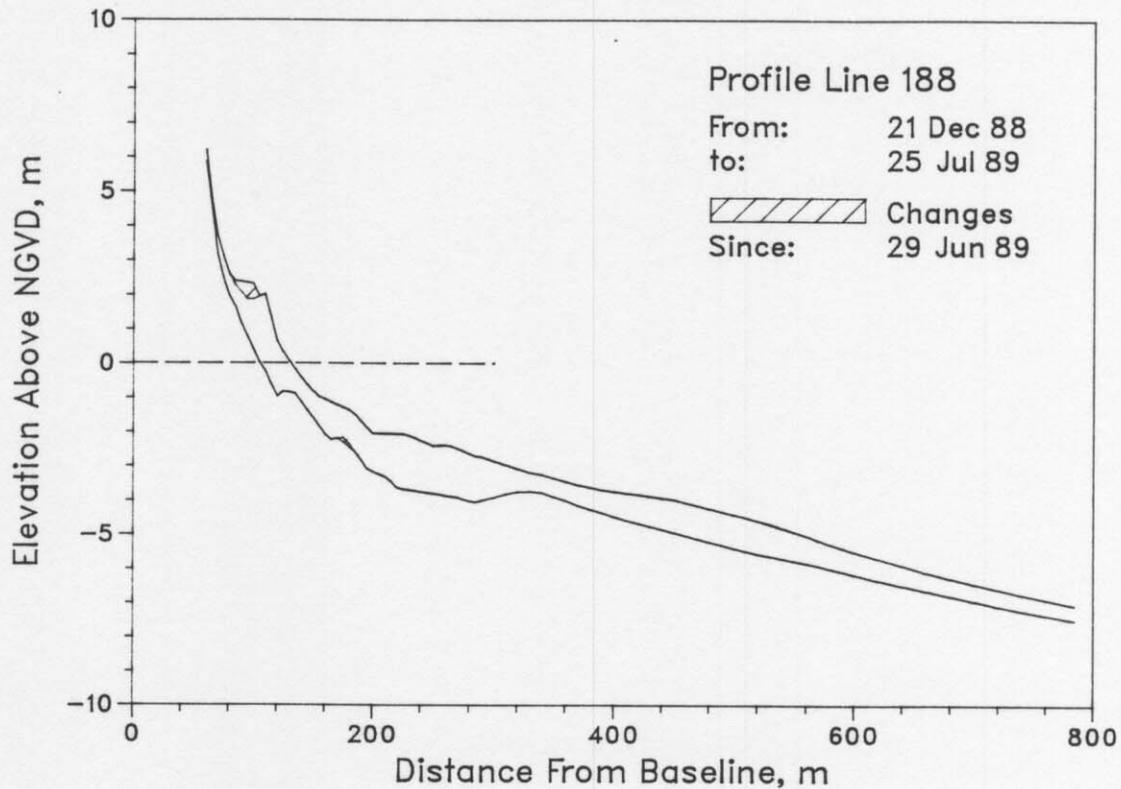


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 26 July. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

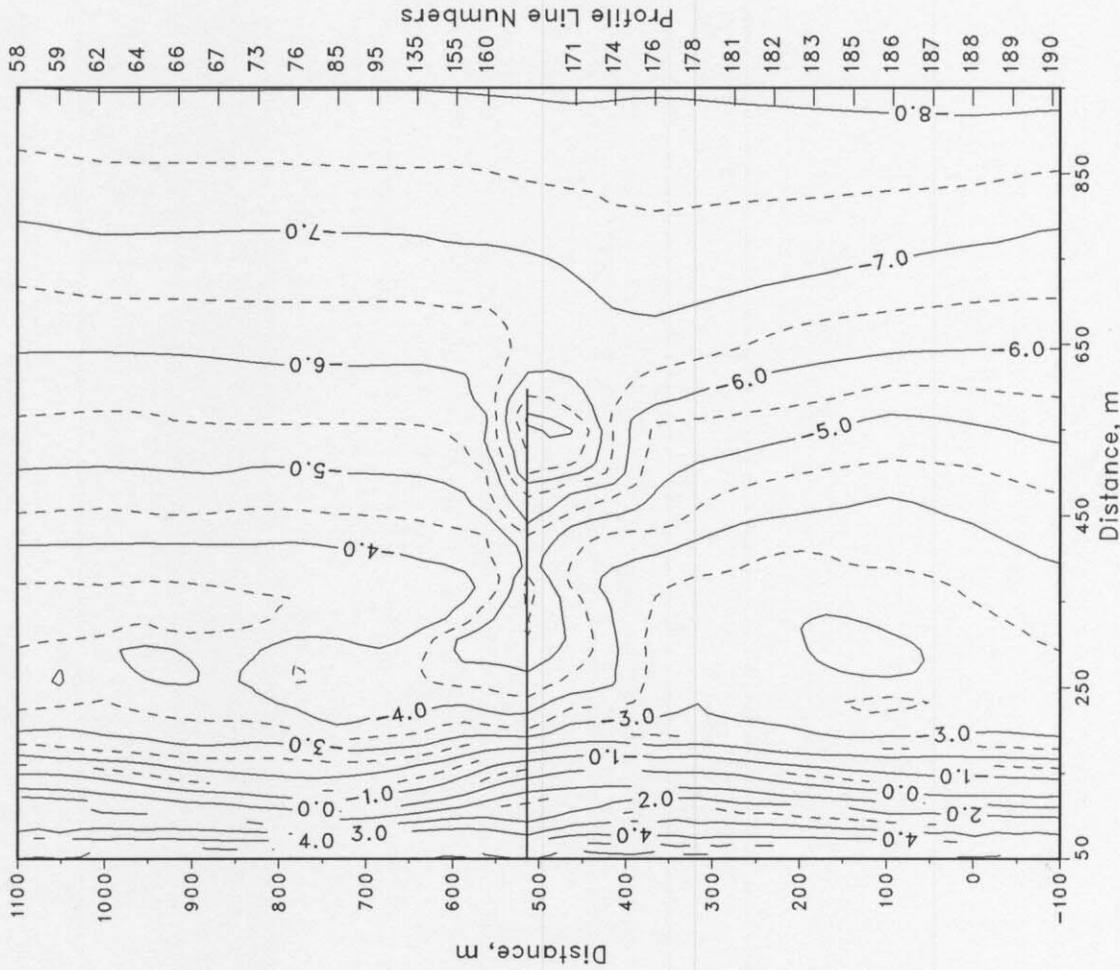
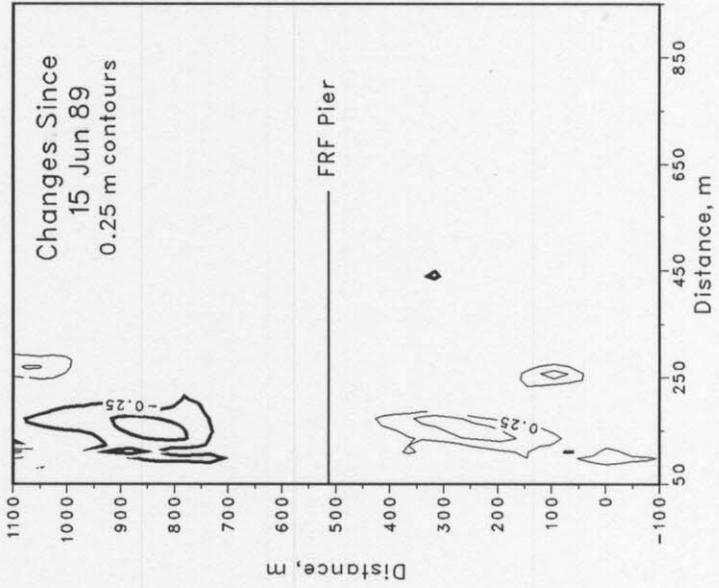
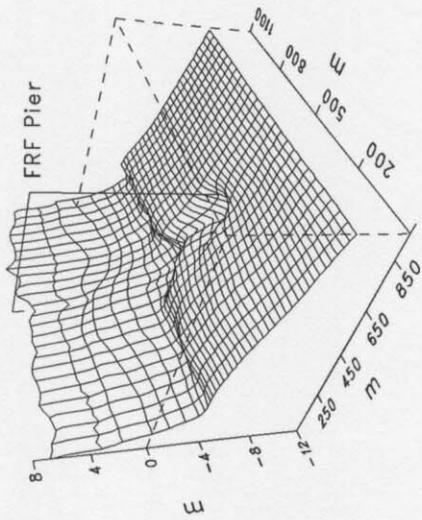


Figure 7. FRF bathymetry 26 Jul 89 depths relative to ngvd

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